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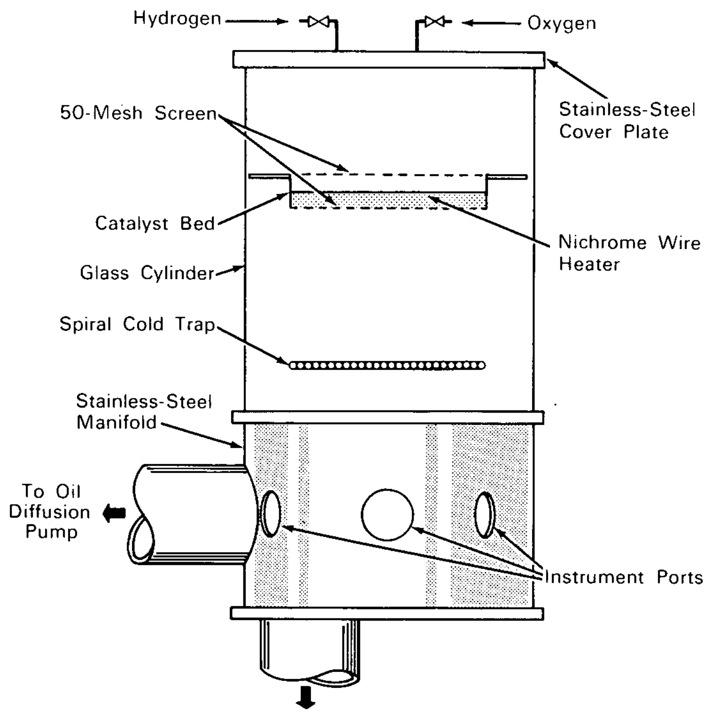
Brief 63-10340

NASA TECH BRIEF

Cryopumping of Hydrogen in Vacuum Chambers Is Aided by Catalytic Oxidation of Hydrogen



The problem: In the development of ion rocket engines using hydrogen as a propellant, vacuum test facilities are required that provide high pumping speeds at pressures as low as one-tenth micron of mercury. The cryopumping of gaseous hydrogen at such low chamber pressures would require condensers cooled to the temperature of liquid helium (4.3°K). A large-scale facility refrigerated below 20°K does not appear to be practical at present. The problem is to develop a practical method for cryopumping of hydrogen in vacuum test chambers.

The solution: A cryopumping method involving the catalytic oxidation of hydrogen and condensation of the resulting water on a liquid-nitrogen-cooled surface.

How it's done: A schematic drawing of one design of a laboratory model of the test chamber is shown in the illustration. The chamber was evacuated by means of a pair of oil diffusion pumps backed by a pair of rotary oil pumps. Condenser surfaces of the cold trap were cooled with liquid nitrogen. Hydrogen and oxygen were introduced at ambient temperature

(continued overleaf)

into the test chamber through ports in the top cover plate. The catalyst was a commercial grade of palladium-coated alumina pellets. A resistance-wire heater in direct contact with the pellets was used to raise the temperature of the catalyst bed. The hydrogen and oxygen react on the catalyst bed and the resulting water is condensed on the cold trap.

Notes:

1. The temperature of the catalyst bed had no noticeable effect on cryopumping performance over a temperature range of 0° to 600°F.
2. Cryopumping performance was not affected by preheating the hydrogen to a temperature of approximately 3,000°K (3,273°C).
3. With 5.8 pounds of catalyst, a pumping speed of approximately 570 liters per second at 1.0 micron of mercury was achieved.
4. Adequate safety protection is required to prevent an overpressurization of the chamber in order to assure against possible explosion of the hydrogen-oxygen mixture.
5. Cold traps should be used with the diffusion oil pumps to prevent backstreaming of oil and other contaminants into the chamber.
6. A variation of this method may be useful as a means of removing extraneous material or avoiding side reactions in chemical processes.
7. Further information concerning this innovation is described in NASA TN D-863, "A Technique for Cryopumping Hydrogen" by Jack Grobman, June 1961, available from the Department of Commerce, Office of Technical Services, Washington, D.C. 20230; price $.75. Inquiries may also be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B63-10340

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA Headquarters, Washington, D.C. 20546.

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